

Characterization of nonindustrial private forest owners and their influence on forest management aims and practices in Northern Spain

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Abstract Explaining and predicting nonindustrial private forest (NIPF) owner land management based on social, economic, and environmental factors is an increasingly important issue in policy arenas and academic research on rural development and planning. This study empirically explores and assesses management behavior by NIPF owners by analyzing attributes of landowner profile (age, educational level, primary occupation, engagement in farming, membership of professional groups, training in forestry, availability of market information, and specific knowledge and use of production criteria for timber harvesting). With the aim of predicting outcomes, a multiple regression model was constructed to investigate and quantify the probabilities of and factors influencing the participation of owners in agricultural and forestry associations. In March 2004, 103 resident forest landowners were interviewed about their commitment to and involvement in land management during 1999–2003 in Mariña Oriental, a forest region of Galicia, Northern Spain. Results suggest that professional occupation, particularly farming background, is the main factor affecting, either directly or indirectly, the forest management behavior of NIPF owners in the area. In particular, our logistic regression model for landowner membership of professional groups explained 77.9% of the variability observed in the study population, which suggests that the agricultural background of NIPF owners and their expectations from forests, represented by their future intention to enlarge the forestland base, play an important role in membership. In the region, forestry could be a valuable economic activity but it is not considered as such today. Findings could be used as a guide for design,

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planning, and implementation of research and policy measures that allow NIPF landowners to promote sustainable forestry for rural development.

Keywords Farming · Forestry · Nonindustrial private forest (NIPF) owner · Planting · Silviculture and harvesting practices

Introduction

Explaining and predicting nonindustrial private forest (NIPF) owner land management based on social, economic, and environmental factors is an increasingly important issue in policy arenas and academic research on rural development and planning, particularly because of the large diversity of factors and the complexity of characterizing and providing a framework for the management objectives and goals of NIPF owners. Because the nature of NIPF ownership differs notably from country to country, defining the meaning of this term is difficult; this type of individual forest ownership consists of a single or small number of planting blocks, nonprofessional management, and often a lack of silvicultural skills, with little planning for future marketing (Herbohn 2001). NIPF owners' commitment to and involvement in land-use and management stems from a dynamic environment in which personal and family decisions and/or needs, geographic context, and policy guidelines are closely interrelated. According to Beach et al. (2005), forest owners produce a variety of forest products and benefits using several types of inputs including forestland, growing timber stock, labor, technical assistance, materials, and machinery to perform various land management activities.

In particular, forests owned by NIPF owners are a part of the total land-use system of the holding, and management goals are not solely focused on industrial timber production; NIPF owners own and manage land for a wide variety of purposes, and thus their practices and values are equally diverse. Therefore, understanding and modeling the determinants of NIPF owners' land-use and management behavior is a complex task, insofar as any analysis must consider the interaction between many decision-making and motivational factors. More specifically, understanding the land management behavior of NIPF owners requires knowledge of the agroforestry system and of the landowners' personal goals and circumstances. Because NIPF owners are key actors in sustainable development and welfare in rural areas, their land management behavior has been studied extensively by researchers from different disciplines, such as sociology, economics, ecology or land planning. Accordingly, there is a growing descriptive, theoretical and empirical literature on the land management behavior of NIPF owners.

In this way, understanding why NIPF owners engage in forestland management has been seen as key by many authors concerned with the choice and level of investment in forest management practices such as tree planting and forest stand improvement (Doolittle and Straka 1987; Straka and Doolittle 1988; Hyberg and Holthausen 1989; Löyland et al. 1995; Hardie and Parks 1996; Gunter et al. 2001; Zhang and Flick 2001; Zhang and Mehmood 2001; Kline et al. 2002; Arano et al. 2004; Ross-Davis et al. 2005), timber harvesting (Hyberg and Holthausen 1989;

Dennis 1990; Kuuluvainen and Salo 1991; Löyland et al. 1995; Kuuluvainen et al. 1996; Prestemon and Wear 2000; Zhang and Mehmood 2001; Bolkesjø and Baardsen 2002; Conway et al. 2003; Størdal et al. 2008), and nontimber forest activities (Pattanayak et al. 2002; Conway et al. 2003; Kittredge 2005; Potter-Witter 2005; Van Gossum et al. 2005; Van Gossum and De Maeyer 2007; Boon and Meilby 2007). The choice and level of investment in different forest management practices has been analyzed as a function of different variables that may affect land management decisions and practices. Pattanayak et al. (2002), Amacher et al. (2003), and Beach et al. (2005) concisely and systematically review some empirical studies focused on land management decisions made by NIPF owners.

The Autonomous Community of Galicia, a region in Northern Spain, provides an interesting setting for the analysis of NIPF owners' management. During the last 50 years, forestry in Northern Spain has undergone significant changes brought about by Spain's entry into a highly competitive market. Such changes have altered the landscape patterns of the region. Fewer farms, decreasing rural populations, and increasing fragmentation of forest property have led to significant alterations in the traditional farming system (Marey-Pérez et al. 2006; Marey-Pérez and Rodríguez-Vicente 2008). These changes have also affected forests. After a period of neglect, the current approach to forest management emphasizes timber production using fast-growing species. Galicia has over 2 million ha of forestland, which accounts for 50% of the total land area of this region and 8% of the total land area of Spain. The Galician forestry sector has grown slowly but steadily over the last 15 years, and is currently one of the economic mainstays of the region. According to the 1998 Spanish forestry survey (MMA 1998), almost 50% of the timber produced in Spain comes from Galicia, which is the Spanish region with the highest standing volume and growing stock.

Land-use changes have affected the social and economic structure of land management in Galicia. Until the mid 19th century, the typical land manager profile in Galicia was a crop or livestock farmer clearly linked to family knowledge and needs. In other words, the Galician rural economy was largely based on subsistence farming, with a large share of forestland. From that moment, the diversification and specialization of the industrial sector and the development of a range of policy tools for encouraging the capitalization of marginal agricultural lands have brought about important socioeconomic changes in many Galician rural areas, which have affected land management and planning (Marey-Pérez and Rodríguez-Vicente 2008). From the mid 20th century, a new profile of forest landowner and/or manager has emerged. New forest landowners and/or managers are different from traditional crop or livestock farmers, and have different goals and decision-making processes about their commitment to and involvement with the land. Today, Galician forests are mostly managed by private owners, with about 425,000–673,000 NIPF owners managing over two-thirds of the forest area (Marey-Pérez 2003).

The rapid expansion of forest area has generated many studies and statistical reports concerned with the current state and evolution of forestry resources in Galicia. However, none of these studies has focused empirically on the social and structural factors affecting forest decision-making and management. Despite the long agroforestry tradition of Galicia, few evaluations of its current state and future

prospects have been conducted, which has led research institutions to investigate individual private property management and planning. Small-scale forestry must be recognized as a productive activity in order to invigorate the economy, to make the sector socially attractive, and to maintain the environmental integrity of rural areas (Marey-Pérez et al. 2004).

Knowing and understanding the factors that may influence individual forest management decisions and practices is essential to improve the forestry sector and to shape it as a social, economic, and environmental mainstay in Galicia, and consequently in Spain. As reported by Karppinen (1998), forest management, as a voluntary action, is primarily driven by the motivations of the landowners, i.e., their values and goals. As assumptions about landowner objectives have evolved, so has our understanding of the decisions they make (Amacher et al. 2003). Therefore, the starting point for understanding why NIPF owners engage in land management is to analyze and explain their motivations and objectives with regard to forestlands.

Our aim is to explore and assess NIPF owners' management behavior based on an empirical analysis of attributes of landowner profile, focusing on a sample of forest holdings surveyed in Northern Spain. Thus, based on a thorough analysis of individual landowner characteristics pertaining to age, educational level, primary occupation, engagement in farming, membership of professional groups, training in forestry, availability of market information, and specific knowledge and use of production criteria for timber harvesting, this paper aims to analyze in detail and better understand forest management behavior in the region. Accordingly, we search for a possible statistical relationship or difference between these variables and other factors related to family unit, forest property and land-use changes, or forest economics. In order to complete the results, we have included three practices traditionally used in the relevant literature to predict forest management behavior of NIPF owners, i.e., planting and silviculture on forestland, and timber harvesting on woodland (Löyland et al. 1995; Hardie and Parks 1996; Kuuluvainen et al. 1996; Prestemon and Wear 2000; Zhang and Flick 2001; Kline et al. 2002; Conway et al. 2003; Arano et al. 2004; Potter-Witter 2005; Ross-Davis et al. 2005; Størdal et al. 2008). In addition, these variables are statistically analyzed with respect to the characteristics pertaining to the profile of forest owners.

The characterization of landowners and the identification of patterns in their forest management practices may allow policy-makers to improve existing policies and develop further public measures based on different landowner profiles in terms of their motivations and needs in forestry that encourage landowners to adopt sustainable land management.

Materials and methods

Identification of the population and questionnaire design

This study updates and expands an earlier analysis by Marey-Pérez (2003) exploring private ownership and forest management in the Autonomous Community of Galicia. Data was collected from face-to-face interviews with randomly selected

NIPF owners in Mariña Oriental pilot area, located in Northeast Galicia, Spain (Fig. 1). The study area is representative of much of Northern Spain, where forests cover most of the land (53%) and forestry is an increasing activity (over 46% of

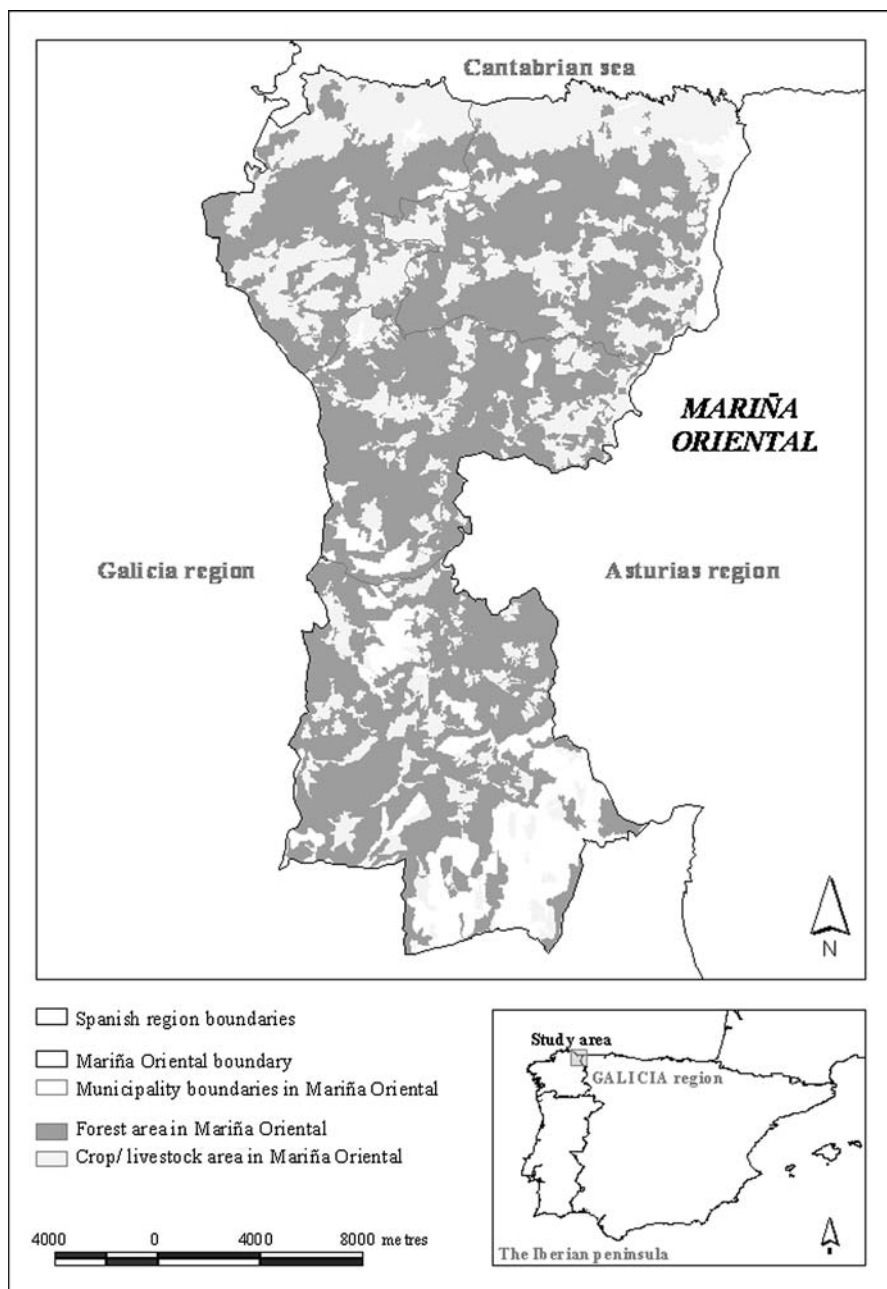


Fig. 1 Location of Mariña Oriental in Galicia, Northern Spain

forests are woodlands). Forestlands are owned by 3,043 NIPF owners, who manage more than 90% of the forested area in the region. In Mariña Oriental, forestland increased by 8.5% between 1957 and 2001 because of the conversion of agricultural land and shrubland into forests, such that the agricultural and farmland area in the region currently accounts for 27% of the total surface area. According to INE (1999), the number of farm holdings declined by 33.7% in Mariña Oriental between 1962 and 1999. Such a decline in the number of farm holdings was caused mainly by social and production deficiencies in rural areas. However, the most important land-use change in the study area and in the Galician region was the composition of woodlands. Monospecific stands increased considerably between 1962 and 1999, about 300%, probably because of the spread of the forest species *Eucalyptus globulus* Labill. (blue gum). Plantations of blue gum increased by more than 63% in Mariña Oriental between 1957 and 2001 (Marey-Pérez 2003). Today, *Eucalyptus globulus* Labill. and *Pinus pinaster* Ait. spp. atlantica (maritime pine) are the main productive forest species in the area and cover more than 71% of the forestland, with a mean timber yield of 26.4 m³/ha per year, at a rotation age of 12 and 25 years, respectively, for blue gum and maritime pine.

The strong increase in timber-producing forests in the study region, in Galicia, and in many other areas of Northern Spain was due to significant changes in the traditional agricultural and forestry system during the 1950s. As a result of increasing urban and industrial development during the mid 19th century, traditional agricultural and forestry activities were no longer economically viable for many rural communities, and active population largely shifted to urban agglomerations, similarly as in other European countries (Marey-Pérez and Rodríguez-Vicente 2008). Changes in land use at farm level are widely acknowledged as a response to decreased agricultural economic viability (Marey-Pérez et al. 2004). The lack of labor in rural areas brought about an increase in abandoned agricultural land, which was gradually occupied by shrub or planted with native trees. From the late 19th century, the Spanish government attempted to tackle the situation by promoting forest plantations primarily used for further processing in the fiber and chipboard industries. The measure reached its peak in the mid 20th century and was aimed at improving the low productivity, low profitability, and deforestation of Spanish forests (Marey-Pérez and Rodríguez-Vicente 2008). Later, European Council Regulation (EEC) no. 2080/1992 of 30 June 1992, instituting a community aid scheme for forestry measures in agriculture, favored the establishment of large forest plantations in Galicia, especially during the period 1993–1997, when grant-aided afforestation constituted an important choice for private landowners who wished to improve the productivity of marginal lands through tree plantations, mainly with *Pinus* spp. and *Eucalyptus* spp.

The addresses of NIPF owners and the attributes of their holdings, such as location, land uses, and size, were identified from the Land Register. In agreement with European Council Regulation (EEC) no. 571/1988 of 29 February 1988, on the organization of community surveys on the structure of agricultural holdings, the study population was composed of individual forest owners who owned at least 1 ha of productive forestland in Mariña Oriental, which totaled 750 forest owners and covered 2,009 ha of productive forestland. The 1-ha threshold value was selected based on the

assumption that only forest owners with a certain land area would have the information necessary to account for their management goals and practices.

A high percentage of the selected owners did not live, however, in the region where their land was located (Marey-Pérez et al. 2004) because of the 20th century migration patterns in Northern Spain, mainly migration from rural to urban areas (Beiras-Torrado 1975). More specifically, over two-thirds of the population of nonresidents lived in other areas of Galicia, and the rest of nonresidents lived in other Spanish regions or in other countries. Consequently, we decided not to include owners who were emigrants or descendants of emigrants because they did not directly manage or monitor their land properties in the study area, and they did not have more or less continuous contact with the land. Moreover, including nonresident owners in the analysis would not guarantee the possibility of obtaining useful information for this research. Accordingly, we used population census data to restrict the study population to registered individual landowners who lived in the area. From among the original population of 750 NIPF owners, 376 were registered as residents, but only 333 actually lived in Mariña Oriental. The remaining 43 NIPF owners were living in the house of a recently deceased relative. Consequently, we had access to around 50% of the owners who met the first condition for the study population. This group of landowners owned 1,154 ha of productive forestland, which accounts for 42% of all productive forestland in the region, including plots smaller than 1 ha. Land Register data proved rather divergent from population census: while according to the Land Register almost all the 750 cadastral landowners lived in Mariña Oriental, the population census suggested that only 45% of landowners actually lived in the region.

Because the large number of variables included in the Land Register was highly heterogeneous, stratification was a key factor in the characterization and subsequent validation of results. According to the Land Register database, the variable “productive forest area per landowner” was the most suitable variable to determine the minimum threshold of NIPF owners that should be interviewed and to stratify landowners. In order to determine the number of strata and the cutoff points required, NIPF owners were classified based on data pertaining to timber harvesting in Mariña Oriental. Landowner stratification was defined by the size of productive forestland that enabled NIPF owners to fell the equivalent of the mean annual harvest per plot in the region (Marey-Pérez 2003), set at 3.5 ha of productive forestland, considering a weighted rotation age of 15 years for the two main forest species in the region, *Eucalyptus globulus* Labill. and *Pinus pinaster* Ait. spp. *atlantica*. NIPF owners were classified into four groups according to this value (Table 1).

We designed a questionnaire based on the subjective method of sample selection. Sample size was designed to achieve a 5% sampling error at the 95% confidence level. A priori, the error level was set at 3% for quantitative answers (mean estimation) and 6% for qualitative answers (proportion estimation). In order to obtain complete and reliable results, we enlarged as much as possible the interviewable landowner sample and minimized the economic costs of the interview during the design of the sampling size. A self-weighting design was used; sample size was determined accordingly and allocated using Neyman allocation (Sukhatme

Table 1 Classification of NIPF owners interviewed per stratum

Stratum	Productive forestland (ha)	No.	%
A	1.00–1.70	22	21.4
B	1.71–3.50	28	27.2
C	3.50–7.00	31	30.1
D	>7.01	22	21.4
		103	100

1953). The results showed that an initial estimate of 3% (mean estimate) required the completion of a total of 101 questionnaires, whereas for an initial estimate of 4% (proportion estimate) completion of 99 questionnaires was required. From 333 NIPF owners, each responsible for more than 1 ha of productive forestland and permanently resident in Mariña Oriental, the self-weighting sample size was finally formed by 103 NIPF owners, who were contacted and interviewed in person (Table 1). Thus, the error level was finally 4% for quantitative answers (mean estimate) and 8% for qualitative answers (proportion estimate).

The NIPF landowners who were interviewed owned 12% of the forestland and 13% of the woodland (i.e., productive forestland) in the region. For the principal productive forest species planted in the area (mainly blue gum and, to a lesser extent, maritime pine), the population of interviewed NIPF owners applied a very simple model for silviculture treatment and forest production. The model was very similar for all the owners and was characterized by an average planting density of 1,100 trees/ha, a minimum use of silviculture treatments, and the use of timber for further processing in the fiber and chipboard industries (Marey-Pérez 2003).

A variety of questionnaires was tested before deciding on a final version, which collected information on owner profile, family unit, forest property and land-use changes, and forest economics during the 1999–2003 period. The survey was carried out in two stages in March 2004. The first stage consisted of a telephone interview conducted between 20:00 and 22:00 h, which inquired into the owner's willingness to participate in the study. If the owner was willing to participate, the interviewer arranged for a face-to-face interview within 1 or 2 days (the second stage). If the owner refused to participate in the face-to-face interview, the interviewer posed the questions included in the landowner-profile section. Each interview lasted an average of 36 min. Finally, data obtained from interviews was complemented with official Land Register data.

The study variables for the present research were based on the information obtained from personal interviews. Such information was redefined and coded into nominal, ordinal or binary variables that summarized data from the survey and met the assumptions of the statistical analyses. For the formulation of ordinal variables, we used SAS/STATTM and STAT-GRAPHICSTM software. First, we produced descriptive statistics and frequency histograms for the explanatory variables and we selected measures of location and dispersion, i.e., mean \bar{x} and standard deviation σ , respectively (Cao-Abad 2002). Then, we considered the measure of location (\bar{x}) as the centre of the explanatory variables considered, and calculated the class intervals

from the measure of dispersion (σ). Definition of the variables considered in the present study, divided into four main topics, along with the number of owners interviewed in each category, are shown in Appendix Table 7, along with the main descriptive statistics for the continuous variables used in the study (x ; σ).

Given that forest decisions and/or practices of a representative NIPF owner are the result of a combination of individual decisions and/or practices regarding planting and silviculture treatments on forestland, as well as harvesting on woodland, these three individual forest practices were also included in the personal interviews and later defined as continuous variables in the present study (Appendix Table 7).

Finally, to control the inflation rate, all the economic variables analyzed in the study were adjusted to constant euros for 2004 and were summarized in mean annual euro amounts per hectare owned, with the exception of family households and stumpage timber price. The information source was the Spanish consumer price index of the National Statistics Institute (INE 2004).

Statistical analyses

The statistical analyses performed in this study were based on distribution-free tests, i.e., nonparametric tests. The nonparametric approach considered the types of variables measured in the study, i.e., continuous, nominal/ordinal, and binary variables, and was defined in order to provide a statistical explanation of NIPF owners' management by analyzing attributes related to landowner profile. The study variables (landowner characteristics) were empirically associated with other attributes pertaining to family unit, forest property and land-use changes, and forest economics, as well as with planting, silvicultural, and harvesting management practices observed in Mariña Oriental region. Thus, the strength and significance of the linear correlation among the variables was firstly tested, and the significant differences found were subsequently contrasted at 95% confidence limit and a minimum 0.05 level of statistical significance.

Somers' D coefficient and its critical significance level were applied to measure the statistical relationship among nominal, ordinal, and/or binary variables by using contingency tables. Then, significant differences in frequency distribution across nominal, ordinal, and/or binary variables of the cross-tabulation were computed and detected by using Pearson's chi-square statistic χ^2 and two-tailed asymptotic significance.

Spearman's rho coefficient ρ was used to estimate the statistical association between the continuous variables and the nominal, ordinal, and/or binary variables at 0.01 and 0.05 significance levels. The mean distribution across variables was analyzed using the Kruskal–Wallis' H test, a nonparametric test of variance homogeneity equivalent to one-way analysis of variance (ANOVA). In addition, pairwise comparisons were performed by using Dunnett's T3 test to determine which categories (levels) of nominal/ordinal variables showed behaviors (means) that differed significantly from the behavior of the continuous variables. After significant differences were tested, post hoc analyses were completed with a Tukey's honest significant difference (HSD) test, which was used to define

homogeneous subgroups of nominal/ordinal variables that displayed a similar statistical behavior with regard to the continuous variables.

Finally, to complete the research presented in this paper, we modeled the relationship between the variables FARM, ASSOC, and IMARKET as binary responses (1 = the owner fulfilled the condition; 0 = the owner did not fulfil the condition) and a combination of explanatory variables that enabled the statistical characterization of these three landowner attributes. The variable TRAINING was not used in the present model because it did not fulfil the balance between responses required to develop a statistically significant model.

Because of the binary nature of the three dependent variables, we used logistic regression by backward stepwise selection, a method based on a cumulative probability function whose main objective is to model how the presence or otherwise of diverse factors, and the value or levels of such factors, affect the probability of an occurrence (Ryan 1997), i.e.:

$$P_i = E(Y = 1 | x_i) = \frac{1}{1 + e^{-(\beta_0 + \beta_i x_i)}} \quad (1)$$

where x_i are the independent variables, $P(Y) = P$ is the probability that the forest owner fulfils the condition set by the dependent variable, which takes a value of 1 when the NIPF owner is an active farmer, a member in a professional group, and had specific training in forest markets, and a value of 0 when the NIPF owner does not fulfil any of the preset conditions, β_0 is the independent term in the logistic regression model, and β_i are the coefficients of the logistic regression model, significantly different from 0.

The estimates of the different regression coefficients were obtained by maximum-likelihood estimation (MLE). Testing of the statistical significance of each of the regression coefficients in the model was carried out by Wald's method, at a significance level of 0.05 (Hosmer and Lemeshow 2000), i.e.:

$$\text{WALD} = \frac{(\hat{\beta}_1)^2}{(EE_{\hat{\beta}_1})^2} \quad (2)$$

This statistic follows a chi-squared distribution with k degrees of freedom χ^2_k , where $k = 1$ if the independent variable is quantitative, and $k = \text{number of categories} - 1$, if the independent variable is qualitative, whether nominal or ordinal.

The empirical models developed for the three landowner attributes analyzed were based on a function that included regressor variables, related to other characteristics of the landowner's profile, the family unit, the forest land-holding and land-use changes, the forest economy, and the three forest management activities considered (planting, silviculture, and harvesting), which were significant at 0.05 level. Appendix Table 7 shows the definition and descriptive statistics of independent regressor variables.

The fit for the logistic regression models for the three landowner characteristics analyzed (the dependent variables FARM, ASSOC, and IMARKET) provided significant results only for landowner membership of an agroforestry association (ASSOC variable). Consequently, we decided to include and discuss only the

predictive model obtained for the behavior of resident NIPF owners in Mariña Oriental in terms of participation in professional groups.

Results and discussion

Owner age

According to literature (Kuuluvainen and Salo 1991; Löyland et al. 1995; Kuuluvainen et al. 1996; Conway et al. 2003; Størdal et al. 2008), owner age appeared to be a significant factor in timber harvesting in the area ($H = 5.672$). Middle-aged owners were the most likely to harvest woodlands, a behavior that differed significantly from the remaining study population. With an annual harvesting rate over 6%, middle-aged owners harvested between four and almost seven times more woodland annually than older and younger owners, respectively. Except for Conway et al. (2003), the authors cited above found that landowner age had a significant negative effect on forest management, particularly on timber harvesting behavior. As suggested by Beach et al. (2005) in their review of empirical economics literature about the forest management behavior of NIPF owners, such a relationship may reflect the landowner's intention to provide standing timber as a bequest to heirs, and this bequest intention may be significant in the productive forest land use of heirs according to their preferences (Amacher et al. 2003).

A moderate negative correlation was found between landowner age and level of formal education ($\rho = -0.550$; $P < 0.01$), a relationship that would indirectly show the key role of the owner's education in forest management. Doolittle and Straka (1987), Straka and Doolittle (1988), Dennis (1990), Löyland et al. (1995), Karppinen (1998), Gunter et al. (2001), and Arano et al. (2004), among others, reported a positive significance of landowner educational level on his/her forestry management goals and decisions. In this sense, younger owners were more likely to have a higher level of education. Thus, all younger owners had formal education, mainly secondary studies (75%), while 63% of middle-aged and older landowners completed primary studies or did not receive formal education ($\chi^2 = 43.792$).

Owner age was strongly and negatively correlated with owner occupation and, more specifically, age was moderately and negatively correlated with the condition of the owner as an active farmer ($\rho = -0.772$ and -0.451 , respectively; $P < 0.01$). Significant differences were found for landowner primary occupation and for his/her condition as an active farmer as a function of the AGE group ($\chi^2 = 71.454$ and 25.167 , respectively). As expected, retired landowners belonged to the older group (93.2%); farming was the most common professional category among middle-aged owners (50%), while <25% of the younger group had farming as their primary occupation. Taking into account that younger owners were the most active planters but the least active harvesters in Mariña Oriental, it could seem reasonable to assume that owners who did not actively work in their property (absentee owners) would be more likely to invest in their lands in order to keep

them productive, as supported by the findings reported by Gunter et al. (2001) and Marey-Pérez et al. (2004).

Landowner age was barely and positively correlated with the likelihood of requesting public subsidies ($\rho = 0.230$; $P < 0.05$). None of the younger landowners asked for financial assistance to make forest management viable, whereas 21.4% of middle-aged and older landowners asked for economics aids. Instead, the likelihood of asking for subsidies showed significant differences according to the owners' willingness to plant former agricultural lands, i.e., to convert marginal meadows into woodlands ($\chi^2 = 3.095$). In Indiana, Ross-Davis et al. (2005) suggested that a shift in land use (afforestation) was occurring on marginal agrarian lands and that public incentives seemed to encourage such a shift. Over 23.5% of owners who did not ask for subsidies converted marginal meadows into woodlands as a production alternative for their holding, as compared with 55.6% of landowners who applied for public funding. In fact, the investment in annually improving and planting the holding weakly increased with the payment of public subsidies received annually in forestry ($\rho = 0.297$; $P < 0.01$ and 0.246 ; $P < 0.05$, respectively). Hyberg and Holthausen (1989), Hardie and Parks (1996), Zhang and Flick (2001), and Kline et al. (2002) are some of the authors who demonstrated that forest planting is positively associated with availability of public financial programmes. As detailed in the following sections, we should also point out that: (i) this type of land-use change was more common among retirees, and (ii) the annual amount of payment per public subsidy was higher in landowner groups formed by retired and active farmers.

Usually, absent landowners do not have time to devote to their forestlands because they are completely busy with other labor requirements. Finley (2002) maintains that this situation may be an additional barrier to organizing in professional groups. Contrary to this assumption, the probability that landowners were member of a professional group or cooperative in the region barely declined in relation to landowner age ($\rho = -0.271$; $P < 0.05$). The younger group had the highest share of members of professional groups, tripling the participation index of older owners ($\chi^2 = 6.624$). Considering that the participation in an agroforestry group in the area was mainly associated with agricultural primary occupations, the considerable share of landowners who worked outside their property and were members of professional groups could be linked to their willingness to balance absenteeism by gaining access to accessory information and technical assistance in land management. According to Kittredge (2005), information cooperation grows significantly as NIPF owners become increasingly detached from their land through absentee ownership and a new generation of younger owners with less interest/experience in management emerges.

The moderate negative association found between annual family income per household and owner age ($\rho = -0.416$; $P < 0.01$) might indirectly contradict the argument put forward by certain authors who have considered timber harvesting as a supplementary source of income for the family during economically difficult times. Hyberg and Holthausen (1989), Dennis (1990), and Kuuluvainen and Salo (1991) concluded that landowner income negatively influenced timber harvesting behavior. However, our findings are in agreement with the results reported by Bolkesjø and

Table 2 Mean annual income (€/year) for homogeneous AGE subgroups

AGE		<40 years old	40–65 years old	>65 years old	<i>P</i> -value
Percentage of interviewed landowners		4.6	44.2	51.2	
HOUSEHOLD	Retired landowner			11,917.8	1.000
	New landowner	24,378.55	22,617.03		0.897

Baardsen (2002) and Potter-Witter (2005) insofar as no statistical evidence was found between these factors. Table 2 shows that the mean value of the annual income of the household is significantly different among age groups when the owners studied are classified according to age. Particularly, the annual family income of older owners was significantly lower than income of middle-aged owners ($H = 22.474$). Thus, 11.4% of older owners earned more than 18,000 €/year, compared with 60.5% of middle-aged landowners who earned that amount; in contrast, 75% of younger owners received an annual income exceeding the economic threshold mentioned.

The degree of parcellation of productive forestland and owner age were weakly and positively correlated ($\rho = 0.257$; $P < 0.05$). Pairwise comparisons suggested that the degree of parcellation of productive forestlands in the region was significantly different for younger and older owners ($H = 4.575$). The number of plots per unit of productive forestland ranged between 1.52 and 3.4 for all younger owners, whereas 48.3% of middle-aged and older owners managed more than 3.4 plots per unit of productive forestland. Such a result could be probably linked to the agricultural occupation of the owner. As reported by Butler et al. (2004), Marey-Pérez et al. (2006), and Marey-Pérez and Rodríguez-Vicente (2008), the demand for improving and increasing current or former agricultural productivity might be one of the main predictors and reasons for fragmenting/parcelling land. This statement would indirectly explain why the most heavily parcelled productive forest holdings belonged to middle-aged and older owners.

Besides, annual planting and silviculture rates in Mariña Oriental barely decreased with increasing parcellation degree of productive forestland ($\rho = -0.293$ and -0.312 , respectively; $P < 0.01$). In addition, the share of woodland harvested annually weakly decreased with increasing number of plots per unit of productive forestland ($\rho = -0.216$; $P < 0.05$). This result might therefore corroborate that larger tracts are more likely to be managed, in agreement with the findings reported by other authors (Doolittle and Straka 1987; Straka and Doolittle 1988; Hyberg and Holthausen 1989; Hardie and Parks 1996; Conway et al. 2003; Potter-Witter 2005; Arano and Munn 2006; Bolkesjø et al. 2007; Størdal et al. 2008).

Level of formal education

The educational level of landowners seemed to statistically influence the planting behavior in the region. The annual rate of planting barely increased with increasing educational level ($\rho = 0.269$; $P < 0.05$). Doolittle and Straka (1987), Straka and Doolittle (1988), Gunter et al. (2001), and Arano et al. (2004), among others,

statistically confirmed this relationship. Educational level is usually interpreted as the owner's ability to manage the existing resources and value them as new opportunities or management challenges, that is, formal education trains and encourages professionalism in certain management skills. In our analysis, landowners with secondary education were the most active planters in the area, with an annual rate of planting significantly different from the rate for uneducated landowners, as shown in Table 3 ($H = 6.685$). According to this table, owners without formal education and owners with secondary education are characterized by clearly different rates of planting. Considering the mean value obtained for this forest practice, these two education-level groups were termed "family planter" and "new planter," respectively. The other groups of owners (primary education and university education) showed an annual rate of planting that could define them as either "family planter" or "new planter." Mean annual expenditures on planting also varied significantly according to the EDUC group; once again, significant differences were between uneducated and secondary-education groups ($H = 4.713$). On average, landowners with secondary education invested annually twice the amount invested by the uneducated group in planting.

The owner profile allowed us to clarify the reason behind this forest management trend in the area. Landowner formal education was moderately and negatively correlated with age, as suggested in the above section ($\rho = -0.550$; $P < 0.01$). As described in Table 3, the tertiary-education group included significantly younger landowners as compared with owners who were uneducated or had completed primary education; furthermore, the mean landowner age for uneducated and primary-education groups differed significantly ($H = 26.173$). Considering the importance of the owner age in his/her educational level and labor situation, we

Table 3 Mean annual rates of planting (%), owner age (year), family income (€/year), and size of productive forest holding (ha) for homogeneous EDUC subgroups

EDUC		No education	Primary education	Secondary education	Tertiary education	<i>P</i> -value
Percentage of interviewed landowners		37.2	47.7	9.3	5.8	
PLANT	Family planter	0.69	1.76		1.54	0.765
	New planter		1.76	4.17	1.54	0.088
AGE	New forester			51.00	48.00	0.931
	Farmer		62.24	51.00		0.116
	Retiree	72.66	62.24			0.163
HOUSEHOLD	Farmer traditionalist	13,137.75	18,935.55	18,875.54		0.535
	New professional		18,935.55	18,875.54	26,714.99	0.270
SIZE	Small landowner	3.26	5.15	6.68		0.150
	Large landowner		5.15	6.68	8.14	0.248

additionally verified that the owner's level of formal education and his/her primary occupation were positively correlated ($D = 0.406$). All owners with tertiary education and half of the owners with secondary education were active workers not linked to agriculture, while 75% and 43.9% of owners who were uneducated or had completed primary education, respectively, were retired farmers; the largest share of active farmers, over 30%, was found in primary-education and secondary-education groups ($\chi^2 = 39.148$).

Landowner level of formal education was also positively correlated with training in forestry, and particularly with the knowledge of timber market conditions ($D = 0.145$ and 0.188 , respectively). Of landowners with secondary education 37.5% were trained in forestry, as compared with 5.2% of landowners who were uneducated or had completed primary education; none of the owners with tertiary education was trained in forestry ($\chi^2 = 10.780$). With regard to the availability of timber market information, primary-education and secondary-education groups included the largest share of landowners with this type of knowledge, near 81%; 56.6% of uneducated owners and owners with tertiary education had information related to timber market. Furthermore, none of the owners with tertiary education had the machinery necessary to carry out forest activities; the best equipped holdings were managed by uneducated owners and owners with primary education, 75.6% and 87.5% of whom, respectively, owned some type of machinery ($\chi^2 = 14.839$). As pointed out in the sections below, engagement in farming could be the reason why owners who had primary or secondary formal education were trained in forestry and had timber market knowledge and logistic resources.

As suggested above, a better level of education would generally improve prospects and success in the labor market. The annual income per family unit weakly increased with the landowner's level of education ($\rho = 0.336$; $P < 0.01$). Significant differences were found between uneducated and tertiary-education groups, with a mean difference in income of more than 13,550 €/year ($H = 10.396$), as shown in Table 3. The positive significant correlations found between landowner's educational level and annual family income or annual rate of planting could indirectly support the findings of many authors who have suggested that high plantation investments are made by landowners with greater household incomes (Doolittle and Straka 1987; Straka and Doolittle 1988; Hardie and Parks 1996; Gunter et al. 2001; Mahapatra and Mitchell 2001; Arano et al. 2004). For example, Beach et al. (2005) mentioned that landowner income may be normally used as a measure of their available resources for forest investment and, hence, better income may imply better access to the capital necessary for planting. However, annual income per family unit was not a significant factor in planting in the region, which is in agreement with Zhang and Flick (2001). We could only verify that the annual expenditure on forest planting increased slightly in relation to annual household income ($\rho = 0.220$; $P < 0.05$), and that there were significant differences in annual household income between the owners who did not invest in planting and the owners who spent between 127.0 and 250.0 €/ha annually ($H = 9.038$).

As described by Dewees (1992), Kurttila et al. (2001), and Marey-Pérez et al. (2004), while some owners would be less dependent on forestry because of the increased proportion of other incomes, farmers as land managers would clearly

seem to be more dependent on forestry as a source of revenue because of a reduced development of the agricultural income. This fact would explain why the annual fraction of forest reinvestments, i.e., the annual rate of forest products that are used within the family unit for self-consumption, increased weakly with the landowner's level of education in the study area ($\rho = -0.215$; $P < 0.05$). The owners with primary and secondary education, which were the groups with the largest share of active farmers, actively benefited from forests for self-consumption, with reinvestments averaging 60.4 €/ha per year. Uneducated landowners, mainly retired farmers, had a mean forest reinvestment valued at 90.5 €/ha per year; this mean value was four times the mean fraction for the tertiary-education group, composed of professionals outside agriculture, in which over two-thirds of them did not exploit forest for self-consumption.

The size of productive forestland and the landowner's level of formal education were barely and positively correlated ($\rho = 0.294$; $P < 0.01$), while the degree of parcellation of the productive forestland was barely and negatively correlated with the educational level ($\rho = -0.236$; $P < 0.05$). Table 3 shows that the mean values of the area of productive forestland in ownership were significantly different between educational groups. The productive forest holdings of uneducated owners were significantly smaller than the holdings belonging to owners with primary education ($H = 7.721$). As regards the number of plots per unit of productive forestland, the largest rate of forest parcellation was observed in uneducated and secondary-education groups, where 26.6% of landowners managed more than 5.29 plots per hectare of productive forestland. As expected, 40% of landowners with tertiary education had <1.52 productive forest plots per hectare. Based on the characterization of landowner's main occupation according to his/her level of formal education, we could verify that there might be a close link between land parcellation and farming activity.

Primary occupation

Karppinen (1998) affirmed that the most significant characteristic of the structural change among NIPF owners was the transfer of forest ownership from farmers to nonfarmers through inheritance, which should be reflected in forestry practices. As a measure of professional occupation, Gunter et al. (2001), Arano et al. (2004), and Potter-Witter (2005) confirmed that the place of residence of the landowner was significantly related to the planting decision. In the region, annual rates of silviculture and timber harvesting showed significant mean differences according to the owner's occupation. As detailed in Table 4, entrepreneurs were the most active silviculturists in the area, differing significantly from the remaining groups, excluding self-employees ($H = 5.155$). Significant differences were found between the mean rates of timber harvesting for retirees and self-employees ($H = 3.053$); retirees annually harvested seven times more woodland than self-employees, who showed the lowest annual rate of timber harvesting in the region. Authors such as Kuuluvainen and Salo (1991) and Kuuluvainen et al. (1996) found a negative statistical association between the intensity of timber harvesting and the landowner's professional occupation. In Central Virginia, Conway et al. (2003) tested that absentee landowners, whose

Table 4 Mean annual rates of silviculture (%) and owner age (years) for homogeneous OCCUP subgroups

OCCUP	Retiree	Farmer	Hired worker	Self-employee	Entrepreneur	Other	P-value
Percentage of interviewed landowners	51.2	24.4	9.3	3.5	4.6	7.0	
TREAT Nonsilviculturist	0.66	1.01	0.65	0.53		0.90	1.000
Silviculturist					6.29		1.000
AGE Active		54.90	48.67	50.88	55.25	53.33	0.763
Retiree	74.50						1.000

residences were located at least 50 miles from their properties, were less likely to harvest.

The strong and negative relationship between landowner age and his/her professional category ($\rho = -0.772$; $P < 0.01$), and the positive relationship between primary occupational and level of formal education ($D = 0.406$) allowed us to characterize landowners who annually carried out considerable forest improvement and timber harvesting in Mariña Oriental. Table 4 shows the means for the owner age that showed significant differences for the study population when such a population was classified according to professional occupation. Particularly, retired farmers were significantly older than the landowners in the other groups, excluding self-employees ($H = 58.282$). In relation to landowner education level, over 55% of retired farmers did not have formal studies, as compared with 37.5% and 31.3% of active farmers and entrepreneurs, respectively, who had tertiary education ($\chi^2 = 39.148$). Based on the landowner profile described here, it would not be surprising that annual income per family unit was slightly and positively correlated with landowner's primary occupation ($\rho = 0.379$; $P < 0.01$). Retired farmers annually received a household income that was significantly lower than the family income of active farmers, with a mean difference of almost 11,500 €/year ($H = 21.396$).

Engagement in farming might probably account for the significant differences observed in the level of membership of professional groups and in the availability of machinery according to the OCCUP group ($\chi^2 = 24.687$ and 12.935, respectively). Of retired and active farmers 49.5% were members of a professional organization, while 29.2% of hired workers and self-employees and none of the entrepreneurs and other professionals was associated. According to these results, the condition of the landowner as an absentee did not seem to be an added barrier to organizing professional groups, contrary to Finley's (2002) report. The best equipped landowners were active farmers and self-employees, 95.3% of whom owned some kind of agroforestry machinery; logistic resources were available for almost two-thirds of retirees and hired workers. Accordingly, the annual rate of silviculture seemed to be weakly and positively correlated with machinery availability ($\rho = 0.373$; $P < 0.01$), and the family labor-force devoted annually to the holding was based on accessibility to this resource ($\chi^2 = 11.158$). Some of the machinery

available, such as chain-saws, pruning-saws or hand-weeders, could be used for forest improvement activities by family labor.

Therefore, the annual amounts of personal and family labor spent within the holding were interrelated ($\chi^2 = 101.468$). The landowners who devoted between 11 and 100 personal labor-days per year to forestry annually benefited from a family labor-force ranging from 11 to 50 labor-days for forestry, while owners who annually spent <5 personal labor-days on the holding received <10 family labor-days per year. In addition, professional assistance in forestry proved an important factor in keeping and making forestry viable in the area, as suggested by other studies about NIPF management (Löyland et al. 1995; Hardie and Parks 1996; Zhang and Flick 2001; Zhang and Mehmood 2001). Thus, the annual amount of professional labor-force on the holding differed significantly according to landowner primary occupation ($\chi^2 = 36.601$). In fact, the annual rates of planted and improved forestlands increased moderately with the number of professional labor-days annually hired in forestry ($\rho = 0.408$; $P < 0.01$ and 0.251 ; $P < 0.05$, respectively). More specifically, 67% of retired and active farmers hired professional labor amounting to <5 days per year, in comparison with 44.5% of the other owner groups, who annually hired professional labor amounting to 51–100 labor-days. These results could clarify the noticeable commitment of professionals outside agriculture to forest improvements, who seemed to hire technical guidance to compensate for their absenteeism in forestry.

The land acquisition pattern varied significantly based on the main occupation of owners ($\chi^2 = 22.191$). Retired farmers represented a specific group, with holdings that were mainly acquired by purchasing or inheriting. In brief, retired farmers would be more likely to make land transactions, probably to improve and increase their former agricultural productivity, and hence show a more significant land mobility (Marey-Pérez et al. 2004). Thus, whereas 59.1% of retirees managed inherited and purchased lands, purchase was the sole pattern of land acquisition for 22.9% of hired workers and self-employees; inherited and purchased lands were combined in 25.8% of the remaining occupational groups. This orientation towards farming could again clarify the significant differences found in the annual rate of forest reinvestment between retired or active farmers and self-employees or entrepreneurs ($H = 15.833$). Over 70.5% of retired and active farmers took advantage of forest reinvestments between 71 and 233.7 €/ha per year, whereas 66.7% of self-employees owners and none of the entrepreneurs obtained forest products for self-consumption.

Annual expenditure on forest plantation and landowner's professional category were weakly and positively correlated ($\rho = 0.235$; $P < 0.05$). None of the active farmers allocated more than 250 €/ha per year on planting forestlands, probably associated with a greater likelihood of managing agricultural land, but large expenditures were exclusively incurred by retired farmers or professionals unrelated to agriculture. Thus, self-employees and entrepreneurs annually invested in planting the highest amounts in the region, over 355 €/ha per year. This annual amount exceeded the mean expenditure on planting by retired and active farmers, almost 165 €/ha per year. In keeping with previous studies (Karppinen 1998; Gunter et al. 2001; Marey-Pérez et al. 2004), the owners that were more likely to invest in lands

to keep them productive seemed to be the owners outside agriculture who worked part-time at their property, and also retired and older landowners.

The key role of public subsidies in forest involvement in Mariña Oriental was again evidenced by the large share of owners who were financially compensated by means of public funding in forestry. Thus, the annual amount of public subsidies and the landowner's professional occupation were barely and negatively correlated ($\rho = -0.236$; $P < 0.05$). None of the landowners unrelated to agriculture, that is, hired workers, self-employees, entrepreneurs, and other professionals, received public financial aid for forestry. On the contrary, the greatest beneficiaries of this type of measure were farmers; 76.9% of retired owners and all of the active farmers who asked for public incentives for forestry finally received the subsidies, with a mean payment of 54.7 €/ha per year. The degree of parcellation of productive forestland and the landowner's occupational group were barely and negatively correlated ($\rho = -0.265$; $P < 0.05$), which confirms that agricultural productivity could be an important factor in land parcellation in the study area. The largest number of plots per unit of productive forestland corresponded to retired and active farmers, with an average of 3.5 plots per hectare of productive forestland. Conversely, hired workers and entrepreneurs managed the least parcelled holdings, with over 2.4 plots per unit of productive forestland.

Condition as an active farmer

Literature concerned with the land management behavior of NIPF owners suggests that farmers, as land managers, are distinct from other landowners in terms of their commitment to and involvement in forestry. Thus, Hardie and Parks (1996) found that the level of planting was negatively associated with the landowner's condition as a farmer. However, Hyberg and Holthausen (1989) observed that the choice of timber harvesting was positively related to the landowner's profile as a farmer. Similarly, Kuuluvainen and Salo (1991) reported that farmers were characterized by significantly lower harvest volumes than other types of NIPF owners. In Mariña Oriental, only a weak positive correlation was found between the annual rate of silviculture and the landowner's condition as an active farmer ($\rho = 0.212$; $P < 0.05$). The fact that active farmers were slightly more active with regard to silviculture could be explained by considering that these landowners were occupied in agriculture full-time ($H = 3.829$). In agreement with Löyland et al. (1995), landowner's occupation outside his/her property may mean having less time available for working the land, and therefore the landowner is less likely to carry out forest practices him/herself. Because of their close association with the land, farmers would actively manage their property themselves and, particularly, they would generally have more time for forest management (Zhang and Mehmood 2001; Lindroos et al. 2005).

The moderate and negative relationship between landowner age and his/her condition as an active farmer ($\rho = -0.451$; $P < 0.01$), and the small and positive relationship between the annual family income and the owner's occupational profile ($\rho = 0.343$; $P < 0.01$) allowed us to characterize active farmers in the area. Post hoc analyses revealed that the mean age of active farmers was significantly

lower than the mean age of nonfarmers, with a difference of almost 15 years ($H = 17.297$). With regard to the landowner's household income, active farmers annually received an average family income of 23,855 €, exceeding by more than 8,800 € the income of the remainder ($H = 10.023$). Such distributions would be probably associated with the inclusion of all the retirees in the nonfarmer group (which accounts for 51.2% of the whole study population in Mariña Oriental), which would increase owner age and decrease the landowner's mean earning per family unit in this group.

As suggested in preceding sections, the professional associations in the area could be mainly agricultural groups, especially cooperatives or trade unions. The equipment available on the majority of holdings could be a proof of the nature of the associations. The assumptions were confirmed by the positive correlations observed between these two factors and the owner's condition as an active farmer ($D = 0.508$ and 0.312 , respectively). Only 20% of nonfarmers were members of a professional organization, as compared with 76.2% of active farmers ($\chi^2 = 22.422$). With regard to the availability of agroforestry machinery, active farmers were characterized by a large personal labor-force annually devoted to forest management, which would explain why 90.5% of them had equipment on their holding, as compared with 55.4% of the other landowners ($\chi^2 = 8.478$). In fact, the agricultural link might also explain the low increase in the annual amount of forest reinvestments when the landowner was actively related to agriculture ($\rho = 0.304$; $P < 0.01$). The active farmers annually took advantage of forest reinvestments twice as often as the nonfarmer group ($H = 7.840$).

Moreover, the profile of owners as active farmers and their production requirements and goals for land management would explain why such landowners could consider the option of using part of their forestlands for agricultural production. Consequently, significant differences in the likelihood of converting forestlands into meadows according to the FARM group were tested ($\chi^2 = 6.338$). As expected, none of the nonfarmers adopted this productive orientation for their holding, and only 9.5% of active farmers considered such an option. Furthermore, we could verify that professional engagement in agriculture and the pattern of land transmission were negatively correlated, for the reasons already explained ($D = -0.255$). Of the nonfarmer group 53.8% were characterized by managing inherited and purchased lands, as compared with 19% of active farmers; for each nonfarmer who owned a fully inherited landholding, there were almost two active farmers who owned this type of holding ($\chi^2 = 7.769$). Patterns of land acquisition and future transmission may be important indicators of NIPF owner land decisions; thus, Hardie and Parks (1996) and Ross-Davis et al. (2005) showed that maintaining the viability of the property by land management by future landowners through inheritance may be a key in securing continuity of the forestry sector.

The following results verified this hypothesis about land capitalization for the study area: first, the pattern of land acquisition in the region significantly influenced the annual rate of planting forestlands ($H = 5.973$), and second, annual expenditure in planting weakly increased in forest holdings that combined inherited and purchased lands ($\rho = 0.224$; $P < 0.05$). Landowners whose holdings combined inherited and purchased lands, which was a group largely represented by retirees,

annually planted over seven times more forestland than owners whose holdings were acquired solely through purchasing, and almost twice the forestland planted by owners whose holdings were acquired solely through inheritance. In addition, owners with inherited and purchased lands annually spent almost ten times more in planting than the others ($H = 6.732$).

A negative association was found between the conversion of marginal meadows into woodlands and the condition of the landowner as an active farmer ($D = -0.233$). The farming group hardly considered such a shift in land use for their holding (9.5%), as compared with 33.8% of nonfarmers who put it into practice in order to keep their land productive ($\chi^2 = 4.667$). Therefore, land capitalization might largely respond to the owner's willingness to improve land productivity and to ensure a complementary source of household income by means of forest investment. Landowners who implemented such a land-use change declared having done so as a way of ceasing farming (67%) and because of the higher profitability of forestry (21%). These findings would support the statement by Beach et al. (2005) that the increase in forest income with respect to agricultural income may tend to increase forest management.

Membership of agricultural and forestry groups

Landowners who are members of cooperative organizations share information, techniques, experiences, and advice with one another (Kittredge 2005; Van Gossum and De Maeyer 2007). The most representative model of professional associations in the study area was a private professional group partially supported by public funds. Participating as a member in this type of landowner organization appeared to be a significant determinant in the annual planting and silviculture management behaviors in Mariña Oriental ($H = 3.648$ and 3.376 , respectively). The associated landowners were slightly more active with regard to planting and silviculture than the nonassociated group. The biggest impact on uptake of planting by the segment of landowners who were members of an organization was also tested by Doolittle and Straka (1987), Straka and Doolittle (1988), and Mahapatra and Mitchell (2001). Such active forest management behavior of associated landowners could be due to the fact that professional groups offer information sources and technical advice for members. However, we were unable to associate this finding with the access of landowners to professional services from agricultural and forestry groups, as Mahapatra and Mitchell (2001), Kittredge (2005) or Van Gossum et al. (2005) suggested.

The important role of professional groups in planting and silviculture management would seem to be related to the owner's engagement in farming. As cited above, the level of participation in a professional body was positively correlated with the landowner's occupation in agriculture ($D = 0.508$). Only 8.8% of nonassociated owners were active farmers, as opposed to almost 55.2% of associated owners ($\chi^2 = 22.422$). More specifically, 59.6% of nonassociated owners were retired farmers, as compared with more than 34.5% of associated owners ($\chi^2 = 24.687$). This result could explain why participation in such groups was weakly and negatively correlated with owner age ($\rho = -0.271$; $P < 0.05$), but weakly and

positively correlated with annual family income ($\rho = 0.259$; $P < 0.05$). Associated owners were almost 10 years younger than nonassociated owners ($H = 6.249$). With regard to the annual household income, associated owners earned almost 7,000 €/year more than nonassociated owners ($H = 5.691$).

The owner profile, and particularly his/her occupation as an active farmer, could justify that the level of participation in professional groups and the availability of equipment on the holding were positively correlated ($D = 0.433$). There were two associated owners for every nonassociated owner who had suitable agroforestry machinery to support land management ($\chi^2 = 16.128$). Technology users would seem to be more likely to participate in social groups and to share experience, which verifies the findings reported by Hodges and Cubbage (1990). Taking into consideration the statistical relationship between the availability of machinery and the annual rate of silviculture, and the significant differences in this forest practice depending on the landowner's level of participation in professional groups, it would not be surprising to find that associated owners were more interested in changing their current productive forest species in the short/mid-term. Thus, the intention of replacing the current productive forest species in the future increased with the level of participation of landowners in professional groups ($D = 0.207$). The number of associated owners who intended to change the main productive forest species in the near future was matched by the number of nonassociated owners, possibly due to the larger labor-force devoted to silviculture ($\chi^2 = 3.902$). This statement was supported by the finding that 80% of owners intended to replace the current productive forest species with *Eucalyptus globulus* Labill. The weak positive correlations found between this future land-use intention and the annual rate of and expenditure on silviculture confirmed this hypothesis ($\rho = 0.238$ and 0.216 , respectively; $P < 0.05$). Landowners who intended to replace the main productive forest species annually treated four times more forestland ($H = 4.809$), and invested in silviculture almost twice as much as those who did not ($H = 3.833$), hence their interest in eucalyptus, a fast-growing forest species that is highly productive and easy to manage.

Other future intentions, such as increasing woodlands on the holding, increased with the participation of landowners in professional groups ($D = 0.211$). Over 58% of associated owners mentioned their intention of increasing their productive forestlands in the near future, as compared with 37% of nonassociated owners ($\chi^2 = 3.697$). The major reason for this behavior could be attributed to previous harvests and timber sales, that is, to the interest in timber production. In fact, the annual rate of harvesting woodlands in the region increased strongly in proportion to annual income from timber sales and stumpage price per unit ($\rho = 0.809$ and 0.781 , respectively; $P < 0.01$). Kuuluvainen and Salo (1991), Bolkesjø and Baardsen (2002), and Bolkesjø et al. (2007) statistically proved that timber price (roundwood, pulpwood or sawtimber) positively affects harvest choice and intensity or volume, and timber supply. The future intention of enlarging woodlands weakly increased with the annual rate of timber harvesting ($\rho = 0.242$; $P < 0.05$). Landowners who had the intention of enlarging woodlands harvested annually twice as much woodland as the remaining owner population ($H = 4.972$), with an annual timber income of 100 €/ha more ($H = 3.118$) at almost twice the stumpage price per unit

($H = 3.104$). On average, associated landowners annually benefited from a 1.5 times higher timber income, with a stumpage price per unit 0.61 €/T higher than the price for the nonassociated group. In addition to the purpose of changing the current productive forest species, the future increase in woodlands seemed to correspond to landowners with an extensive surface area. In keeping with Hodges and Cubbage (1990) and Van Gossum et al. (2005), we observed that the productive forest holdings managed by owners who were members of a professional group were somewhat larger than the holdings of owners uninterested in participating in such groups. As mean values, associated owners had almost 1 ha more than the nonassociated group ($H = 3.768$).

Table 5 shows the results of the logistic regression model for estimating landowner membership of agricultural and forestry associations. At 1% statistical significance, the fitted model correctly predicted 77.9% of the overall observations. The binary variables FARM and MACHINERY, represented as the status of the owner as an active farmer and his/her availability of agroforestry machinery within the holding, respectively, and the binary variable IFOREST, represented as the owner's intention of enlarging the productive forestland in the short/mid-term, proved to have a significant positive effect on explaining the landowners' condition as a member of a professional group in the study region, as previously suggested and analyzed:

$$P(\text{ASSOC}) = \frac{1}{1 + e^{(-3.873 + 1.425\text{IFOREST} + 2.380\text{MACHINERY} + 2.460\text{FARM})}}$$

These results show that active farmers were almost 12 times more likely to be included in an agroforestry association than were retired farmers or other professionals not related to agriculture. Those landowners who had agroforestry machinery within their holding as support to land management were almost 11 times more likely to partake in an association related to the sector than landowners without any type of logistic resources. Finally, those owners who had the future aim

Table 5 Parameter estimates of the logistic regression model that examines the factors affecting NIPF landowner membership of agroforestry associations

Variable	Coefficient	Wald	P-value	Standard error
FARM	2.460	12.661	0.000	0.691
MACHINERY	2.380	7.750	0.005	0.855
IFOREST	1.425	5.167	0.023	0.627
Constant	-3.873	17.012	0.000	0.939
-2 Log likelihood	71.637			
Model χ^2	38.300*			
Nagelkerke R^2	0.498			
Obs. with ASSOC = 1	51.7			
Obs. with ASSOC = 0	91.2			
Overall % correct	77.9			

* $P \leq 0.01$

of increasing the productive forestland base were four times more likely to be members of a professionals group than landowners who tried to keep their territorial system stable.

Specific knowledge about forestry: availability of market information

Zhang and Mehmood (2001) stated that NIPF owners are nowadays characterized by increasing information and education. Gunter et al. (2001) and Arano et al. (2004) are some of the authors who have statistically confirmed that information sources (books, bulletins or the media, among others) and attendance to educational programs, respectively, affect forest decision-making and management level. In the study area, only the annual rate of harvesting woodlands increased barely with landowner timber market knowledge ($\rho = 0.274$; $P < 0.05$). The annual rate of timber harvesting for the group of owners who had market information was twice the rate for the remaining landowners ($H = 6.391$). Actually, the stumpage price per unit from previous harvests weakly rose when the owner had information on the timber market ($\rho = 0.282$; $P < 0.05$). Owners with this type of knowledge sold timber at 2 €/T more than owners who did not have timber market information ($H = 6.442$).

As expected, the likelihood of having knowledge about timber market conditions and training in forestry were positively correlated ($D = 0.184$). All trained owners knew about timber market conditions, as compared with 63.3% of untrained owners ($\chi^2 = 3.877$). As suggested earlier, knowledge of forestry would correspond mainly to owners engaged in farming; 57.1% and 28.6% of trained landowners were retired and active farmers, respectively, and were usually characterized by a low level of formal education. Moreover, the landowners' knowledge of forestry and the availability of timber market information were positively associated with the level of formal education ($D = 0.145$ and 0.188 , respectively). All trained owners completed, at least, primary studies, an educational level that 39% of untrained owners did not complete ($\chi^2 = 10.780$); all the landowners with tertiary education belonged to the untrained group, and there were seven trained owners for every untrained owner who had secondary education.

As previously mentioned, the farmers surveyed generally managed their lands themselves and had more experience and better knowledge about forest management than did other landowners. This could explain why owners who were better trained in forestry were statistically more likely to spend more personal time on the holding annually ($D = 0.209$). All owners with forest training worked annually more than 50 personal labor-days on the holding, and 14.3% of them exceeded 100 labor-days per year; in contrast, 58.3% of untrained owners spent <50 personal labor-days per year on forestry ($\chi^2 = 10.113$). Spending more time working on the property could effectively result in better forestry training, which would qualify landowners for managing lands and taking a more active role in forestry. This pattern of personal forest management would also clarify why agroforestry machinery was a more common resource on holdings managed by owners who were better trained in forestry ($D = 0.192$). All trained owners were equipped with suitable machinery to work on their property, as compared with 60.8% of owners

who were not trained in forestry ($\chi^2 = 4.295$). These results would confirm that active and retired farmers were better trained in forestry.

Considering the profile of the owner, and according to the above results, it was not surprising that the likelihood of managing inherited and purchased lands was positively correlated with training in forestry and availability of timber market information ($D = 0.195$ and 0.169 , respectively). Almost 54.4% of untrained owners had holdings acquired by inheritance, whereas more than 71.4% of trained owners managed inherited and purchased lands ($\chi^2 = 5.715$). Moreover, all trained owners intended to pass their holding on to their heirs, regardless of profitability, while 9% of the untrained group expected to sell it in the near future ($\chi^2 = 5.011$). Land transfer governed by emotional values (i.e., bequeathing) could be a good reason to care for the holding and pass it on to future generations, which would explain why landowners in the region continued to work their land in spite of not receiving regular income from it. Thus, the ownership of the forests may be more important as symbolic capital than as a source of income (Niskanen et al. 2007). In fact, significant differences were found between the personal labor-force used annually for forestry and the future plans for the property ($\chi^2 = 18.287$). All landowners who intended to pass some part of their land on to their heirs spent more than 10 labor-days per year on their holding, and more specifically, half of them worked more than 100 labor-days per year; on the contrary, 67% of owners who intended to sell all their lands devoted <2 labor-days per year to forestry. As suggested by Karppinen (1998), Hugosson and Ingemarson (2004), and Ingemarson et al. (2006), NIPF owners can have many different goals and motivations that affect their forest practices in different ways and, in this sense, bequeathing might be a significant motivation for securing the continuity of forest management, according to the future heirs' preferences (Amacher et al. 2003).

Knowledge and use of production criteria for timber harvesting

In a review of economic models for timber supply, Wear and Parks (1994) concluded that the manager's optimum harvest age depended on current and expected market conditions. Thus, the owner can decide whether or not to harvest timber commercially based on market perspectives. In Mariña Oriental, the annual rate of timber harvesting slightly increased when the landowner understood and carried out forest rotation at the appropriate age ($\rho = 0.347$; $P < 0.01$). Moreover, the mean annual rate of timber harvesting varied significantly depending on the owner's knowledge and use of production criteria ($H = 10.909$). Post hoc analyses showed that owners who knew and applied the suitable rotation age in timber harvesting were the most active harvesters in the region, even though significant differences were statistically observed between the two remaining groups of owners (T_{E1} and T_{E2} groups). Table 6 shows that the mean values of the annual rate of harvesting significantly differed among the owners studied when they were classified according to their knowledge and use of forest requirements. These results allowed us to identify two landowner subgroups, where particularly nonharvesters might not apply the suitable rotation age for their productive forest species, in spite of understanding productive forest criteria.

Table 6 Mean annual rates of harvesting (%), family income (€/year), and stumpage price per unit (€/T) from timber sales for homogeneous TECHNIC subgroups

TECHNIC		No knowledge–no application	Knowledge–possible application	Knowledge–application	<i>P</i> -value
Percentage of interviewed landowners		8.1	81.4	10.5	
HARV	Nonharvester	0.00	3.07		0.416
	Harvester			9.84	1.000
TINCOME	Non-wood seller	0.00	178.28		0.072
	Wood seller		178.28	210.70	0.913
TPRICE	Non-timber industrialist	0.00	4.00		0.054
	Timber industrialist		4.00	6.95	0.199

Forest management practices that consider the suitable rotation age for the productive forest species generate high-quality timber products and, as a result, timber is of higher value. The timber selling price fixed from previous harvests weakly increased when the landowner had knowledge of and applied the optimum rotation age ($\rho = 0.337$; $P < 0.01$). As Table 6 shows, owners who did not know and did not apply productive forest criteria sold timber at a significantly lower stumpage price per unit than the rest ($H = 9.941$); 44.4% of landowners who knew and applied the suitable rotation age in timber harvesting fixed a timber selling price higher than 48.9 €/T, as compared with 13.6% of the owners who knew these forest requirements but did not apply them in previous harvests. More than 30% of these owners harvested below/above the rotation age of their productive forest species, because they imitated the harvesting pattern of adjoining landowners (20%) or because they wanted to improve their family economy (12%). As expected, annual timber income barely increased when the landowner took into account these production requirements ($\rho = 0.265$; $P < 0.05$). As Table 6 also shows, owners who did not know and did not apply productive forest requirements stood out with a significantly lower annual timber income than the remaining population ($H = 7.946$).

In the profile of the owner who knew and used the suitable rotation forest age, we observed that almost 60% of owners who had knowledge of the suitable rotation age (T_{E2} and T_{E3} groups) were retired farmers, as compared with owners who lacked this technical requirement (T_{E1} group), who were mainly active farmers and professionals outside agriculture (42.9% and 28.5%, respectively). The relationship of the landowner with agriculture would explain why the pattern of land acquisition significantly varied according to the TECHNIC group ($\chi^2 = 10.352$). More than 88% of owners who knew and applied productive forest requirements in previous harvests mainly managed inherited and purchased lands, as compared with half of the other landowners, who owned holdings acquired solely through inheritance. As already explained, improving and increasing agricultural productivity could make the increase of land mobility among retired farmers possible (Marey-Pérez et al. 2004). Former engagement in agriculture would also explain the significant differences found for the rate of conversion from forestland into meadow, and the opposite land-use change from marginal meadow into woodland, as a function of

the knowledge and application of production requirements in timber harvesting. None of the owners who knew and applied the suitable rotation age converted forestlands into meadows, while 7.9% of the remaining landowners considered agricultural production in their forestlands ($\chi^2 = 4.870$). Conversely, none of the owners who did not know or apply technical requirements in timber harvesting considered changing marginal meadows into woodlands, as opposed to 22% of the rest of owner groups who decided to invest in forestry ($\chi^2 = 4.824$). This finding would support that both retired farmers and professionals not linked to farming were initiating forestry over marginal lands as an asset.

Conclusions and implications

Individual forest decision-making and management are complex processes that result from the personal landowner's goals and interests with regard to his/her land property. In turn, the goals and interests of NIPF owners are dependent on social, cultural, economic, political, and environmental factors. As a previous step to promoting supporting policies and tools for NIPF land management, the present study examined individual forest management by empirical analysis of the role and importance of characteristics of the landowner profile. Among the factors affecting individual forest management are the family unit, the territorial system, and the forest economy, in addition to the preferences and circumstances of the managers. Within this analysis framework, our study was based on land management data for 1999–2003 obtained from a personal questionnaire completed in 2004 by 103 resident NIPF owners, each of them responsible for more than 1 ha of productive forestland in Mariña Oriental region, located in Northern Galicia, Northern Spain.

The results suggested that:

- (i) The owner's level of formal education and his/her membership of professional groups were associated with forest planting. Landowners who completed intermediate studies and those who were members of professional groups were the most active planters in the region. This NIPF owner profile corresponded to a middle-aged owner with a high family income, who did not earn his/her living from agriculture and who managed a large productive forest holding.
- (ii) The landowner's primary occupation, specifically his/her condition as an active farmer, and membership of professional groups were related to stand improvement treatments. Active workers not related to farming stood out by being more likely to invest in silviculture by hiring professional assistance. However, it was necessary to distinguish a group of planters and silviculturists who were clearly different from this profile. Such owners were retired and active farmers who invested significant amounts in planting and silviculture, respectively. In this case, forest training, membership of professional groups, and machinery availability noticeably supported forest management based on personal and family labor-force.

- (iii) The principal occupation of the owner was linked to timber harvesting, as well as his/her age, the availability of information about timber market conditions, and knowledge and use of productive forest criteria from previous harvests. The most dynamic harvesters obtained a higher income from their forests at a better stumpage price per unit. These owners were mainly profiled as middle-aged owners, professionals outside agriculture or active farmers, and those who usually had information related to timber market conditions and experience in forest production criteria.

From among the landowner characteristics analyzed in this study as binary responses, only the participation of owners in agricultural and forestry associations could be modeled in relation to other sociodemographic and territorial attributes. The logistic regression model for landowner membership of professional groups, a condition associated with the annual planting and silviculture practices in the area, suggested that landowner membership of professional groups was significantly and positively influenced by aspects related to farming activity (owner's status as an active farmer and his/her availability of agroforestry machinery on the holding). However, the owners' future intention of enlarging the productive forestland in the short/mid-term was also found to be important.

In conclusion, a solid agricultural tradition seems to result in a distinct land user and manager, a farmer or a descendant of farmer who is familiar with forests. Such a NIPF owner profile would be characterized by a close relationship with working the land, which is associated with the physical proximity of the landowner to his/her forest holding, but a lack of professionalism in forest matters. Forestry, as a land practice clearly differentiated from other land uses, seems to be in an initial state of implementation within rural economies, sharing many objectives and management practices with agriculture, but not at the same level in economic and training terms. Moreover, forestry is not widely adopted as a primary occupation. Consequently, forestlands are an important part of the surface area of a landowner's rural holding and are usually considered as a possible investment for complementing family income and contributing to land capitalization. As a result, the interest of NIPF owners in forestry cannot be expressed in explicit economic terms (forestland as a means of generating income from timber production) or in sociological terms (land as capital to bequeath to future generations), but rather as a combination of both land management behaviors.

Our findings can be used as a guide for the design, planning, and implementation of research and policy measures that allow NIPF owners to promote forestry for rural development according to two main profiles, forest farmers and nonfarming foresters, with clearly different goals and prospects for the land. Based on this assumption, public tools and programmes focused exclusively on forestry and applied separately from other land-use alternatives in an agricultural region would partially encourage land capitalization and management by means of forest production. Such tools and programmes would not improve sustainable rural development or land planning. Rather, they would further unbalance the agroforestry land-base and social structure. In brief, suitable research and policy measures must focus on rural development and welfare, supporting an entrepreneurial attitude

among individual private landowners and managers, such that the productivity of their holdings is improved and the economic viability of rural areas is promoted. Hence, an interesting direction for future research involves examining the role of efficient forest management in ensuring the future prosperity of rural areas. Such an analysis would imply identifying the key determinants of forest management by characterizing landowners, their holdings and the market or policy framework. According to such an analysis, measures could better represent the landowners' socioeconomic perceptions and values, trying to develop sustainable forestry and farming in the same individual economy, and with rural planning as a key framework.

Appendix

See Table 7.

Table 7 Definition of the study variables for statistical analyses

Variable	Code	Definition	No. of interviewed NIPF owners
<i>Landowner forest management practices</i>			
PLANT	–	Forest planting, measured as the proportion of area planted annually in the entire forest area ($x = 1.57\%$; $\sigma = 2.66\%$)	103
Continuous			
TREAT	–	Stand improvement treatments, measured as the proportion of the area in which silvicultural treatments are carried out annually within the entire forest area ($x = 1.02\%$; $\sigma = 2.93\%$). This includes activities such as the use of fertilizers, application of insecticides, pesticides or herbicides, thinning of competing vegetation, and other treatments to improve stands	103
Continuous			
HARV	–	Timber harvesting, measured as the proportion of the area harvested annually in the entire wooded forest area ($x = 3.53\%$; $\sigma = 6.12\%$)	103
Continuous			
<i>Landowner profile</i>			
AGE		Age of the owner, in years ($x = 64.24$; $\sigma = 13.63$)	
Ordinal	1	If owner was <40 years old	5
	2	If owner was 40–65 years old	45
	3	If owner was more than 65 years old	53
EDUC		Regulated education of the owner	
Ordinal	1	If owner did not have studies	38
	2	If owner had primary education	49
	3	If owner had secondary education	10
	4	If owner had tertiary education	6

Table 7 continued

Variable	Code	Definition	No. of interviewed NIPF owners
OCCUP		Main primary occupation of the owner	
Nominal	1	If owner was a retired owner	53
	2	If owner was an active farmer	24
	3	If owner was a hired worker	10
	4	If owner was a self-employee	4
	5	If owner was an entrepreneur	5
	6	If other	7
FARM		Condition of the owner as an active farmer	
Binary	1	If owner was an active farmer	24
	0	If otherwise	79
ASSOC		Participation of the owner in professional associations	
Binary	1	If owner was a member of a professional association	35
	0	If otherwise	68
TRAINING		Forestry training of the owner	
Binary	1	If owner participated in a forestry course	8
	0	If otherwise	95
IMARKET		Specific training in market (timber prices, supply-demand, etc.)	
Binary	1	If owner had market information	35
	0	If otherwise	68
TECHNIC		Knowledge and use of production criteria for timber harvesting	
Nominal	1	If owner did not know about and did not take into account rotation age	8
	2	If owner knew about and did not take into account rotation age	84
	3	If owner knew about and took into account rotation age	11
<i>Family unit</i>			
INHERIT		Acquisition of the forest holding	
Nominal	1	If owner inherited lands	53
	2	If owner inherited and bought lands	46
	3	If owner bought lands	4
BEQUEST		Intention of bequeathing the forest holding	
Nominal	1	If owner intended to bequeath lands to heirs	97
	2	If owner intended to bequeath some lands to heirs and sell the remainder	2
	3	If owner intended to sell lands	4
HOUSEHOLD		Annual net family income in euros during 1999–2003 ($x = 17,224.94$; $\sigma = 10,339.69$)	
Ordinal	1	If net household income was <6,000	11
	2	If net household income was between 6,000 and 9,000	18
	3	If net household income was between 9,001 and 18,000	37

Table 7 continued

Variable	Code	Definition	No. of interviewed NIPF owners
REINVEST Ordinal	4	If net household income was between 18,001 and 30,000	20
	5	If net household income was more than 30,000	17
		Annual reinvestment for household consumption in euros during 1999–2003, per unit of forest area ($x = 71.01$; $\sigma = 81.32$)	
	0	If owner did not obtain reinvestments	29
	1	If reinvestment was <71.0	33
	2	If reinvestment was between 71.0 and 152.4	24
	3	If reinvestment was between 152.5 and 233.7	11
	4	If reinvestment was between 233.8 and 315.0	4
PERSONAL Ordinal	5	If reinvestment was more than 315.0	2
		Personal labor-days spent annually on forestry during 1999–2003	
	1	If personal labor was <2	31
	2	If personal labor was between 2 and 5	11
	3	If personal labor was between 6 and 10	13
	4	If personal labor was between 11 and 50	32
	5	If personal labor was between 51 and 100	12
	6	If personal labor was more than 100	4
FAMILY Ordinal		Family labor-days spent annually on forestry during 1999–2003	
	1	If family labor was <2	44
	2	If family labor was between 2 and 5	12
	3	If family labor was between 6 and 10	8
	4	If family labor was between 11 and 50	15
	5	If family labor was between 51 and 100	18
	6	If family labor was more than 100	6
MACHINERY Binary		Logistic resources available for forestry activities	
	1	If owner had agricultural and forestry machinery	66
	0	If otherwise	37
PROFESS Ordinal		Professional labor-days spent annually on forestry during 1999–2003	
	1	If professional labor was <2	41
	2	If professional labor was between 2 and 5	6
	3	If professional labor was between 6 and 10	23
	4	If professional labor was between 11 and 50	12
	5	If professional labor was between 51 and 100	19
	6	If professional labor was more than 100	2
<i>Forest property and land-use changes</i>			
FMEADOW Binary		Past conversion of forestland into meadow during 1999–2003	

Table 7 continued

Variable	Code	Definition	No. of interviewed NIPF owners
	1	If owner made this land-use change	2
	0	If otherwise	101
MWOOD		Past conversion of marginal meadow into woodland during 1999–2003	
Binary	1	If owner made this land-use change	29
	0	If otherwise	74
CSPECIE		Future intention of changing the current productive forest species	
Binary	1	If owner had this future purpose	23
	0	If otherwise	80
IFOREST		Future intention of increasing the productive forestland	
Binary	1	If owner had this future purpose	46
	0	If otherwise	57
PLOT		Number of plots per hectare of productive forestland in ownership ($x = 3.40$; $\sigma = 1.88$)	
Ordinal	1	If fragmentation degree was smaller than 1.52	14
	2	If fragmentation degree ranged between 1.52 and 3.40	41
	3	If fragmentation degree ranged between 3.41 and 5.29	29
	4	If fragmentation degree was larger than 5.29	19
SIZE		Area of productive forestland in ownership, in hectares ($x = 4.76$; $\sigma = 3.86$)	
Ordinal	1	If ownership sized between 1.00 and 1.70	22
	2	If ownership sized between 1.71 and 3.50	24
	3	If ownership sized between 3.51 and 7.00	32
	4	If ownership sized more than 7.00	25
<i>Forest economics</i>			
INVEST		Annual investment in holding improvement in euros during 1999–2003, per unit of forest area ($x = 10.35$; $\sigma = 24.56$)	
Ordinal	0	If owner did not invest in the forest holding	76
	1	If owner invested <39.7	15
	2	If owner invested more than 39.7	12
PEXP		Annual expenditure on plantation in euros during 1999–2003, per unit of forest area ($x = 193.48$; $\sigma = 176.28$)	
Ordinal	0	If owner did not spend on planting forestlands	5
	1	If owner spent <127.0	61
	2	If owner spent between 127.0 and 250.0	25
	3	If owner spent between 250.1 and 400.0	7
	4	If owner spent between more than 400.0	5
TEXP		Annual expenditure on silviculture treatments in euros during 1999–2003, per unit of forest area ($x = 71.83$; $\sigma = 81.76$)	
Ordinal			

Table 7 continued

Variable	Code	Definition	No. of interviewed NIPF owners
REQUEST Binary	0	If owner did not spend on forestland improvement	12
	1	If owner spent <90.7	63
	2	If owner spent between 90.7 and 221.7	20
	3	If owner spent more than 221.7	8
		Formal application for a forest management subsidy during 1999–2003	
SUB Ordinal	1	If owner applied for economic aid	22
	0	If otherwise	81
		Annual forest subsidy in euros during 1999–2003, per unit of forest area ($x = 4.92$; $\sigma = 20.09$)	
	0	If owner did not apply for economic aid or was not finally compensated	95
	1	If owner received <25.0	2
TINCOME Ordinal	2	If owner received between 25.0 and 50.1	2
	3	If owner received between 50.2 and 75.2	2
	4	If owner received more than 75.2	2
		Annual income from timber sales in euros during 1999–2003, per unit of forest area ($x = 166.62$; $\sigma = 193.39$)	
	0	If owner did not receive timber income	46
TPRICE Ordinal	1	If owner received <195.1	18
	2	If owner received between 195.1 and 425.2	19
	3	If owner received more than 425.2	20
		Stumpage price in euros during 1999–2003, per ton ($x = 3.99$; $\sigma = 4.25$)	
	0	If owner did not sell timber	46
NTINCOME Ordinal	1	If stumpage price per unit was <48.9	40
	2	If stumpage price per unit was between 48.9 and 74.3	11
	3	If stumpage price per unit was more than 74.3	6
		Annual income from land sales in euros during 1999–2003, per unit of forest area ($x = 170.79$; $\sigma = 281.77$)	
	0	If owner did not receive nontimber income	35
	1	If owner received <381.8	52
	2	If owner received more than 381.8	16

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